NISTTech

MICROWAVE HEATING FOR SEMICONDUCTOR NANOSTRUCTURE FABRICATION

Rapid, controlled growth of a variety of nanowires

Description

This method selectively produces a variety of nanowires under a highly controlled, rapid growth mechanism. Different morphologies of the one dimensional silicon carbide (SiC) nanostructures of 3C-SiC may be grown by appropriately adjusting the process parameters of this catalyst-assisted sublimation method. SiC nanowires are grown by combining a physical vapor transport (PVT) process and a catalytic vapor-liquid-solid (VLS) growth mechanism using catalysts from Group VIII transition metals. The type of nanowire produced (e.g., faceted nanowires having straight sidewalls, nanoneedles, and nanocones having tapering sidewalls) may be controlled.

Using an energy source such as a microwave apparatus, semiconducting material from the source wafer is moved to a substrate wafer via a physical vapor transport mechanism (sandwich-sublimation). Nanowires are catalyzed to grow on the substrate wafer in a nitrogen atmosphere under temperatures ranging between 1650-1750 degrees Celsius for 40 second durations.

Applications

- **Sensors**
  Fabricate nanoelectric devices and nanoelectromechanical systems (NEMS) for chemical/biochemical sensing. Applicable for high temperature, high frequency and aggressive environments.

Advantages

- **Fast growth rate**
  Rapidly grows 1-2 μm/s
- **Controls morphology**
  Shape and size as well as location and orientation are controlled in this technique
- **Controls product features**
  Controlled polytypes and doping concentrations
- **Economical**
  High process yield and low cost

Abstract

The present invention grows nanostructures using a microwave heating-based sublimation-sandwich SiC polytype growth method comprising: creating a sandwich cell by placing a source wafer parallel to a substrate wafer, leaving a small gap between the source wafer and the substrate wafer; placing a microwave heating head around the sandwich cell to selectively heat the source wafer to a source wafer temperature and the substrate wafer to a substrate wafer temperature; creating a temperature gradient between the source wafer temperature and the substrate wafer temperature; sublimating Si- and C-containing species from the source wafer, producing Si- and C-containing vapor species; converting the Si- and C-containing vapor species into liquid metallic alloy nanodroplets by allowing the metalized substrate wafer to absorb the Si- and C-containing vapor species; and growing nanostructures on the substrate wafer once the alloy droplets reach a saturation point for SiC. The substrate wafer may be coated with a thin metallic film, metal nanoparticles, and/or a catalyst.

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Citations

1. S.G. Sundaresan, A.V. Davydov, M.D. Vaudin, I. Levin, J.E. Maslar, Y. Tian, M.V. Rao, Growth of Silicon carbide Nanowires be a Microwave Heating-Assisted Physical Vapor Transport Process Using Group VIII Metal Catalysts, Chem. Mater. **19** (23), 5531-5537 (2007).

References

- US Patent 7,994,027, issued 08-09-2011
- Docket: 09-019

Status of Availability

This invention is available for licensing exclusively or non-exclusively in any field of use.

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